MANAGEMENT PLAN

FLATWOODS SALAMANDER

Ambystoma cingulatum

February 21, 2001

Approved

Date February 21, 2001

Florida Fish and Wildlife Conservation Commission
620 South Meridian Street
Tallahassee, Florida 32399-1600

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EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) proposes to add the flatwoods salamander, *Ambystoma cingulatum*, to the Species of Special Concern list with a prohibition of direct take except through permit authorized by the executive director or his delegate. Rule 68A-1.004, Florida Administrative Code (F.A.C.), defines "direct take" as "intentionally pursuing, hunting, capturing, killing, or destroying fish or wildlife or the nests, eggs, homes, or dens of fish or wildlife." Since the proposed rule imposes fewer restrictions on land use than the federal listing of the flatwoods salamander as a threatened species (U.S. Fish and Wildlife Service [USFWS] 1999), and since the state permit required for direct take is a no cost permit, FWC does not anticipate any economic impacts to any affected parties as a result of management plan implementation. If the rule is not implemented, the potential exists for the flatwoods salamander to become increasingly imperiled.

Previous FWC listing actions invoked criticism from both the conservation and development communities for the lack of a clear statement of required management necessary to conserve and protect the species. This management plan presents (1) an assessment of the threats believed to be responsible for the flatwoods salamander's apparent status as a Species of Special Concern, (2) an identification of the conservation goal and objective targeted by the management plan, and (3) the recommended conservation actions, FWC regulations, and incentives whose implementation would help attain that goal and objective. The plan also outlines a monitoring plan to assess flatwoods salamander status, an implementation strategy for the management plan, and areas for future research.

The FWC conservation goal of restoring the flatwoods salamander to a level where the species does not meet the state criteria for listing as a Species of Special Concern would necessitate maintenance in perpetuity of at least 129 self-sustaining populations of flatwoods salamanders in Florida, each of which is verified by the presence of larvae at least once every 5 years. Strategies to achieve this conservation objective include (1) maintenance of the 38 known self-sustaining Florida populations where they currently occur, (2) locating additional extant populations, and (3) establishment of additional flatwoods salamander populations within the historic range of the species in Florida where habitat conditions are favorable but salamanders appear to have been extirpated.

This management plan fulfills the requirements of Rule 68A-27.0012, F.A.C. (Appendix 1) which went into effect June 29, 1999. The listing process for flatwoods salamander was triggered by FWC acceptance of a valid petition for listing action (Appendix 3) following its federal listing as Threatened by the USFWS (1999). The FWC assessed flatwoods salamander biological status in a Final Biological Status Report (Appendix 4). Based upon that report, in March 2000, the FWC determined that listing of the flatwoods salamander as a candidate for Species of Special Concern

designation was warranted and directed FWC staff to develop a species management plan for consideration during the March 29-30, 2001 FWC meeting.

Public comments and outside review were formally solicited and incorporated at several junctures during the listing process for flatwoods salamander. In addition to scientific peer review ("Expert Reviewer Contacts," Appendix 12), the following public comment periods were noticed in the Florida Administrative Weekly:

(1) October 22 - December 6, 1999 to solicit information on the biological status of the flatwoods salamander to be considered during the development of the Final Biological Status Report,

(2) May 12 - June 26, 2000 to solicit information on the conservation needs of the flatwoods salamander and any economic and social factors that should be considered in its management,

(3) October 13 - November 28, 2000 to solicit public comment on the Draft Management Plan, including any information regarding the anticipated regulatory economic and social impacts of management plan implementation.

In addition, public comments were presented at the FWC meeting of March 29-31, 2000, when FWC reported its findings regarding the flatwoods salamander's biological status. The March 29-30, 2001 FWC meeting provides additional opportunity for public comment relative to the proposed listing action.

TABLE OF CONTENTS

LIST OF APPENDICES

SPECIES MANAGEMENT PLAN

INTRODUCTION

The flatwoods salamander (*Ambystoma cingulatum*) is a small-headed stocky salamander with a total adult length of about 5 inches which breeds in seasonally inundated isolated wetlands within pine flatwoods in the Southeastern Coastal Plain. Its historic range is from Alabama to South Carolina, including the Florida Panhandle and the Florida Peninsula as far south as Marion County. Recent surveys conducted within the historic range of the flatwoods salamander revealed apparent population declines due to decreases in population numbers, area of occupancy, extent of occurrence, and quality of habitat.

In 1999, the USFWS (1999) listed the flatwoods salamander as federally threatened, prompting the FWC to develop a petition (Appendix 3) to list it as threatened in Florida pursuant to Rule 68A-27.0012, Florida Administrative Code (F.A.C.) (Appendix 1). The FWC directed staff to assess flatwoods salamander biological status in a Final Biological Status Report (Appendix 4). Based upon that report, in March 2000, the FWC determined that listing of the flatwoods salamander as a candidate for Species of Special Concern designation was warranted and directed FWC staff to develop a species management plan for consideration during the March 29-30, 2001 FWC meeting. This management plan fulfills the requirements of Rule 68A-27.0012. Public comments and outside scientific review were solicited and incorporated at several junctures during this process.

The flatwoods salamander management plan includes (1) an assessment of the threats believed to be responsible for the flatwoods salamander's apparent status as a Species of Special Concern, (2) an identification of the conservation goal and objective targeted by the management plan, (3) the recommended conservation actions and FWC regulations and incentives whose implementation would help attain that goal and objective, (4) a monitoring plan to assess flatwoods salamander status, (5) an implementation strategy for the management plan, and (6) suggested areas for future research. The recommended conservation action section includes a "toolbox" of management practices to assist in the elimination or reduction of potential threats to flatwoods salamanders on public and private lands. Depending upon the specific conditions and history of a given site, landowners may find 1 or more of these conservation actions appropriate for the voluntary enhancement of the flatwoods salamanders on their lands.

DEFINITIONS

The following glossary defines scientific terms as they pertain to flatwoods salamander assessment, conservation, and research described in this management plan.

Population	A group of individuals of the same species that occurs in a defined area at the same time and regularly interact or interbreed. Unless otherwise defined, for flatwoods salamanders, a population is defined as a group of individuals that regularly shares 1 or more breeding sites (ponds) separated by less than 2 miles. Animals at breeding sites farther apart are considered to be from separate populations.
Florida Population	All individuals of the species within the state of Florida.
Range-wide Population	All individuals of the species throughout the entire extent of its area of occurrence. For flatwoods salamanders, the range-wide population includes individuals found in Florida, Georgia, South Carolina, and Alabama.
Metapopulation	The aggregate of all neighboring populations that are close enough to allow occasional gene flow between them. Interactions should occur at least once per generation.
Robust Population	A group of interacting or interbreeding individuals that is believed to have a greater than average chance of long-term viability. For flatwoods salamanders, robust populations are those that use 3 or more breeding ponds and thus have a high likelihood of successfully breeding each year.
Viable Population	A stable, self-sustaining population with a high probability (e.g., more than 95%) of surviving for a long-term period (e.g., 100 years).
Long-term	An extended period of time relative to the life span of individuals in a population. Length is based on commonly used viability procedures and practicality, but is typically at least 100 years.
Area of Occupancy	The geographic area inhabited by all individuals in a population. Typically, the area of suitable habitat in which individuals are known to occur.
Extent of Occurrence	The geographic area encompassing all locations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range.
Known Population	Population where larvae have been verified within the past 5 years.

THREAT ASSESSMENT

FWC staff undertook an assessment of the underlying cause(s) of apparent population declines in flatwoods salamanders as a necessary precursor to the design and implementation of effective conservation measures. First, FWC staff identified the population parameters which put the species at risk. The criteria used to distinguish species as Endangered, Threatened, or Special Concern are listed in the definitions in Rule 68A-1.004 (F.A.C.) (Appendix 2). The Final Biological Status Report (Appendix 4) specified 3 criteria underlying the proposed designation of the flatwoods salamander as a Species of Special Concern.

1. ***Population reduction.***—There is a suspected reduction of at least 20% (as compared to 50% for Threatened) over the last 10 years based on (a) possible decline in occurrence of breeding sites of 64.5% during previous 50-year period, (b) inferred 60-80% loss of original pine flatwoods habitat, and (c) likely decline in habitat availability or quality of at least 20% in the last 10 years.

2. ***Extent of occurrence, area of occupancy.***—The flatwoods salamander's extent of occurrence is unclear, but may be less than 7,700 square miles (which still exceeds the 2,000 square miles threshold for listing as Threatened). Its area of occupancy is estimated to be less than 770 square miles (but more than the 200 square miles threshold for Threatened) based on surveys, and (a) its populations are severely fragmented, with 52 isolated populations known range-wide, including 38 populations known from 12 counties in Florida (Palis 1997b, Means 1998, USFWS 1999); (b) although extensive surveys are badly needed, at present extant populations are not known from 4 historically occupied counties in Northeast Florida (Bradford, Alachua, Marion, Duval) nor from Escambia and Gulf counties in the Panhandle, and several historic sites in Calhoun and Jackson counties in the Panhandle are believed to no longer support populations; and (c) continuing declines in habitat availability and quality will likely continue to reduce the area of occupancy, the number of occupied locations, and the number of mature individuals throughout the current range.

3. ***Population size and trend.***—The total range-wide population of flatwoods salamanders is estimated to number fewer than 10,000 mature individuals (but more than the 2,500 threshold for Threatened). In addition, it is reasonable to estimate that continuing declines in habitat availability and quality will produce a continuing population decline of at least 10% within 10 years (as opposed to 20% over 5 years for Threatened).

The second assessment step involved an examination of threat factors potentially giving rise to the apparent population declines in flatwoods salamanders. The following threat factors have been

proposed by 1 or more researchers although specific data demonstrating cause and effect for flatwoods salamander declines due to these threats are generally lacking, and further research is warranted.

1. **Loss and degradation of pine flatwoods and savanna habitat due to development for silviculture**, especially through the following practices.

    a. **Ditching and bedding**, which (1) alter the hydrology, dropping the ground water table and possibly increasing the period of time salamanders must remain in burrows, especially in the dry season, probably reducing overall activity including feeding; (2) may present physical barriers to salamander movement and reproduction; (3) reduce the hydroperiod of the breeding site, thereby limiting the number of successful metamorphs; (4) destroy burrows and underground structure; (5) cause direct mortality to highly vulnerable fossorial salamanders (Ashton and Ashton 1988; Ashton 1992, pers. commun.; Means et al. 1996; Palis 1997b, pers. commun.; Semlitsch pers. commun.; Jensen pers. commun.; LaClaire pers. commun.)
    b. **Mechanical damage to soil from heavy machinery**, including roller chopping, in both breeding ponds and terrestrial ranges, which destroys burrow complexes, alters soil structure, reduces native groundcover, opens habitat for invasion by weedy plant species, possibly alters the hydrology, and causes direct mortality to highly vulnerable fossorial salamanders (Ashton pers. commun., Jensen pers. commun.)
    c. **Firebreaks**, which are often tied in to wetlands, and which provide similar impacts as bedding, reducing the hydroperiod and presenting untenable sites for egg deposition (Printiss and Hipes 2000)
    d. **Fire suppression and reliance on winter burns**, which increase the dominance of woody plants at the expense of the heliophilic groundcover, grasses, and forbs; woody plants shade herbaceous layer, reduce available soil moisture, decrease hydroperiod and hasten successional filling of the pond, shortening its lifetime as a useful breeding site; reduction of peat buildup is prevented, increasing water acidity and thus impacting development of eggs and larvae; also, migrating salamanders may be vulnerable to winter burns (Palis 1997b, Jensen pers. commun., Ashton pers. commun.)
    e. **High stand density**, which reduces sunlight, increases leaf litter, and eventually eliminates native groundcover species which may be important for providing microhabitat and supporting a prey base for salamanders (Means et al. 1996)
    f. **Application of herbicides and pesticides**, which may cause direct mortality, or reduce prey populations and groundcover (Ashton 1992, Palis 1993, Palis and Walker 1993, Palis 1997b)
    g. **Fertilization of pine plantations**, which can cause algal blooms that produce anoxic conditions in breeding ponds (Palis 1993, Palis and Walker 1993, Palis 1997b)

h. **Road construction**, which destroys habitat and may alter the hydrology and impede salamander movement, and makes widespread application of needed prescribed fire more difficult (Palis 1993, Palis et al. 1995, Palis 1997b, Jensen pers. commun.)

2. **Loss and degradation of pine flatwoods and savanna habitat due to development for agriculture (row-crop production and beef production)**
   a. Several of the same practices as are listed above for silviculture (Jensen pers. commun.)
   b. Cypress ponds isolated in cow pastures are reduced to "hog wallows," over-enriched by manure, and thus made unsuitable for salamanders (Palis 1993)

3. **Loss, degradation, and fragmentation of pine flatwoods and savanna habitat due to real estate development,** especially in coastal areas (Palis 1993, Carmody pers. commun.)

4. **Habitat loss due to cutting of cypress from cypress domes**; heavy machinery used for this may also breach the hardpan that maintains the natural hydroperiod of ponds, preventing larvae from developing fully before the ponds dry up (Ashton 1992, Jensen pers. commun.)

5. **Vehicular traffic on roads** intercepting salamanders migrating between upland habitat and breeding ponds (Palis 1993, Means et al. 1996)

6. **Illegal trash dumping**, which can threaten the integrity of breeding sites (Palis et al. 1995)

7. **Off-road vehicle use** threatens the integrity of breeding sites; breaking of the hard pan may shorten hydrological period, impacting larval survival; potential direct mortality of adults, larvae, and eggs; decreased water quality (increased turbidity); rutting, fragmentation, loss of vegetation, introduction of exotics in disturbed areas, soil compaction (Palis et al. 1995, Jensen pers. commun., Carmody pers. commun., Hancock pers. commun.)

8. **Crayfish harvest in breeding ponds**, during which salamander larvae may incidentally be killed or harvested; depletion of crayfish may reduce the availability of burrows important to salamanders as refugia (Palis 1993, 1996, 1997b)

9. **Depredation by red imported fire ants**, which favor disturbed habitats and are known to attack and kill small terrestrial vertebrates (Means et al. 1996, Ashton pers. commun.)

10. **Over-collection for the pet trade** (Palis 1993, 1997b), although this species was not recorded in a study of reptile and amphibian use and trade in Florida (Enge 1994)

CONSERVATION GOALS AND OBJECTIVES

Conservation Goal for Flatwoods Salamander

Given knowledge of current population status and the threats underlying apparent population decline, it should be possible to set a scientifically defensible, reasonable, and explicit conservation goal for flatwoods salamanders in Florida. However, until more extensive surveys are conducted throughout the range (both known and potential range) of the flatwoods salamander so that comprehensive reliable information is available on its range-wide status, the FWC must necessarily proceed with caution in stating its goals and objectives. **The most ambitious or optimistic conservation goal, and the one toward which this management plan is primarily aimed, is to secure a stable (or increasing) Florida population of the flatwoods salamander at levels above the threshold defining a Species of Special Concern**. If that goal were met, the FWC could determine that removing the flatwoods salamander from the Species of Special Concern list was warranted.

On the other hand, if surveys fail to document any additional occupied or suitable habitat, the FWC may be forced to reassess and select a less optimistic goal of maintaining the Florida populations of the flatwoods salamander at its current levels as a Species of Special Concern. The absolute minimum conservation goal would be to ensure that the flatwoods salamander's status does not decline to the extent that it fulfills the criteria defining a Threatened species.

Conservation Objective for Flatwoods Salamander

To further focus conservation efforts, and to facilitate assessment of progress toward the conservation goal, a single, highly measurable objective was derived for the flatwoods salamander. Restoration of flatwoods salamander populations to a level where the species does not meet state criteria for listing as a Species of Special Concern would necessitate **maintenance, in perpetuity, of at least 129 self-sustaining populations of flatwoods salamanders in Florida, each of which is verified by the presence of larvae at least once every 5 years.**

This objective addresses multiple criteria for attainment of the conservation goal and makes use of the most easily observed life stage of the flatwoods salamander, the larvae. Although much remains to be learned about flatwoods salamander population dynamics, the successive presence of larvae is sufficient to identify a persistent population. The subjective 5-year monitoring interval is less demanding than an annual interval, and should accommodate natural fluctuations in reproductive success. Extant populations are relatively unambiguous units of concern that can easily be counted to determine success in achieving the objective.

The numerical component of this objective is based upon assumptions regarding the distance individual salamanders move to and from breeding sites, the resulting acreage of habitat used by the average population, and how many of such populations Florida would need to sustain in order to meet its area of occupancy requirement to exceed Species of Special Concern status. More and better data that modify these assumptions will in turn enable the FWC to fine-tune this conservation objective (i.e., revise the target number of populations up or down). Assuming that the other states where flatwoods salamanders are or were found (Georgia, South Carolina, Alabama) implement similar conservation efforts for their populations, Florida's goal of at least 129 healthy, self-sustaining populations would constitute 73% of the 177 populations postulated to be needed range-wide in order to satisfy the 770-square-mile area of occupancy criterion associated with the listing as Species of Special Concern. Should the assumption of other states' efforts be unmet, Florida's targets would be modified accordingly.

This is a daunting but perhaps not unreachable objective. Florida is presently known to have 38 geographically disjunct populations in 12 counties (Appendix 7), including some that are obviously robust, using multiple ponds as breeding sites, as well as others that are based solely on the capture or observation of a single individual. Twenty-two of these populations, including the 3 largest, are located on 9 parcels of publicly owned land in 8 counties; the remainder are on private land (Appendix 8). Recent surveys (Palis 1997b) failed to find flatwoods salamanders on at least 30 sites where they had been recorded historically (defined by Palis as pre-1990), although these surveys were not necessarily exhaustive. Twelve of these historic sites were in 6 counties (Alachua, Bradford, Duval, Escambia, Gulf, and Marion) where no extant populations are known. In addition, cursory surveys (Palis 1993) identified at least 9 additional public lands in 7 counties where increased survey efforts may locate additional, but as yet unknown, populations. Although no historic sites are known from there, Ashton (pers. commun.) suggests that Hamilton County may still have sites with high potential for flatwoods salamanders, albeit many fewer than indicated in 1969 aerial photos.

Derivation of the Conservation Objective

FWC staff arrived at the proposed conservation objective after careful consideration of the Species of Special Concern listing criteria. To be considered a Species of Special Concern, a species needs to meet only 1 of the 5 alternative criteria, listed as (a) through (e) in Appendix 2. However, to exceed the threshold for designation as a Species of Special Concern, it would have to be ascertained that the flatwoods salamander met or exceeded all of the criteria. The scientific basis for setting the conservation objective at the level of at least 129 known populations in Florida derives from a mathematical application of the criteria to existing data on flatwoods salamander habitat and life history.

As discussed in the Final Biological Status Report (Appendix 4), population data are generally lacking for the flatwoods salamander. Much of the status assessment was inferred from habitat trend

data, the key assumption being that the flatwoods salamander population in Florida has likely undergone a reduction in population numbers and distribution commensurate with the documented decline in available, suitable habitat. Since detection and census of adult flatwoods salamanders is nearly impossible on a state-wide scale, the most direct method of determining population status, and detecting changes in population status, is to monitor numbers of known populations. Appendix 9 presents a complete discussion of the scientific basis for the conservation objective and its feasibility with respect to each of the 5 listing criteria. The main points can be summarized as follows:

1. **A population reduction of less than 20% either over the last 10 years or projected within the next 10 years is inferred from the trend in flatwoods salamander habitat conversion and degradation.** To assess population status and trend directly, data on the number of known, persistent populations will have to be collected over a sufficient time interval.

2. **Due to its dependence on isolated wetlands in a landscape that has already been fragmented, it is apparent that the flatwoods salamander's distribution range-wide is highly discontinuous, and could be defined as "severely fragmented." Also, it is to be expected that amphibian population numbers fluctuate dramatically from year to year due to differences in amount and duration of precipitation.** Against this background of natural fluctuations, one could define a robust population as one known to be using 3 or more breeding sites, hence potentially having a reduced likelihood that extreme fluctuations will cause local extinction.

3. **The flatwoods salamander's extent of occurrence already appears to span well over 7,700 square miles range-wide (i.e., including other states as well as Florida).** This area would equal a square about 88 miles on the side, or about 13% of Florida's total area of 58,560 square miles. The Florida range maps given in Ashton (1992) and in Petranka (1998) show a suspected gap in distribution between Panhandle and Northeast Florida populations, but the implied total geographic range on each of those maps would still exceed 7,700 square miles.

4. **At an average of 4.36 square miles per population (231 divided by 53), the minimum target area of occupancy of 770 square miles would contain 177 flatwoods salamander populations range-wide (i.e., including other states as well as Florida)**. The 770 square mile area would equal a square about 28 miles on the side, or about 1.3% of Florida's total area. The amount of habitat actually used by a flatwoods salamander population includes the breeding pond or ponds and the associated surrounding flatwoods. Ashton (1992) reported on individuals that traveled up to 1 mile from their breeding pond. Assuming that such movements occur in most flatwoods salamander populations (Appendix 11), a population's minimum habitat requirements could be defined as that area around the pond extending 1 mile from the wetland edge. Therefore, a population using only 1 breeding pond would need a minimum of

3.14 square miles (the area of a circle $A = \eth r^2$ with radius r = 1 mile), but one could postulate that a population using 2 ponds would need less than double the amount needed for 1 pond, perhaps 5 square miles; 3 ponds - 7 square miles, and so on. Using these conventions (Moler pers. commun.), the total area of occupancy for the 53 known populations range-wide is 231 square miles**,** resulting in an average of 4.36 square miles per population (231 divided by 53). Using the postulated average area occupied by a population as a "unit" of area of occupancy, a minimum of 124 additional populations (covering 539 square miles) need to be found or restored range-wide. Florida has about 73% of the known populations (38; Appendix 7), so to achieve its share of the target area of occupancy, Florida should have a total of 129 known populations (0.73 x 177).

5. **The Final Biological Status Report suggested that the sum of all populations range-wide is between 2,500 and 10,000 mature individuals, and it seems reasonable that if an additional 124 self-sustaining populations were found or created one could safely assume the total population consisted of more than 10,000 mature individuals.** The 3 largest populations known (all in Florida: 1 using 21 ponds on Eglin Air Force Base [AFB], 2 using 10 ponds each on Apalachicola National Forest [NF]) probably contain at least 1,000 mature individuals each, although supporting data are lacking at present. If the target threshold of 10,000 individuals were distributed evenly among the 177 populations postulated (53 known + 124 new) above, the average population would contain 56 mature salamanders, which may be reasonable based on known numbers of adults in other populations that have been sampled. The long-term investment of equipment and personnel necessary to actually census the number of adults would make this prohibitively expensive to pursue at more than a handful of populations. Therefore, rather than counting individuals, FWC staff believe it is more reasonable to assume that each self-sustaining population supports at least 56 adults, and to use the count of self-sustaining populations to infer that the target of 10,000 mature salamanders is met.

6. **Current information estimates of population size and distribution suggest that the flatwoods salamander does not meet the criterion for a very small population nor is it acutely restricted.** Current estimates place the population size at above 1,000 mature individuals, with an area of occupancy greater than 40 square miles and the number of locations greater than 5.

7. **Available data are not sufficient to permit estimation or modeling of the probability of extinction of flatwoods salamanders in the wild**. Population demography, habitat association, and other studies would be necessary to yield appropriate data for population modeling, but such studies would be prohibitively expensive and take away from more direct conservation actions. Accordingly, FWC staff believe it is prudent to accept that this criterion

cannot be addressed at this time, and rely instead on counts of self-sustaining populations as an empirical measure of status.

Strategies to Achieve the Conservation Objective

As previously stated, restoration of flatwoods salamander populations to a level where the species does not meet state criteria for listing as a Species of Special Concern would necessitate maintenance, in perpetuity, of at least 129 self-sustaining populations of flatwoods salamanders in Florida, each of which is verified by the presence of larvae at least once every 5 years. Extensive and intensive efforts will be required to (1) survey known and potential flatwoods salamander populations on both public and private lands, (2) implement management actions to enhance their long-term viability, (3) establish a long-term monitoring schedule for periodic range-wide status assessment, and (4) conduct needed research to further enhance our ability to conserve this species. Completion of these tasks cannot be accomplished by the FWC alone, but will require partnerships with public and private land managers.

FWC staff identified 3 key strategies required to achieve the conservation objective. These strategies, listed in priority order of implementation, are as follows:

1. **Maintain the 38 self-sustaining populations where they currently occur.**
    a. Establish a Memorandum of Agreement (MOA) with the USFWS regarding the role of each agency in coordinating and monitoring work on existing populations on federal, state, local government, and private lands.
    b. Conduct systematic surveys of each population to map extent of occurrence and number of breeding ponds used by that population.
        i. The FWC will implement or oversee surveys on sites where it is the lead according to the MOA to the extent possible given budget and logistical constraints.
        ii. The FWC will maintain a database of survey results.
    c. Develop and implement a plan to maintain each population.
        i. Prepare a threat assessment for each identified population, identifying needs and opportunities for habitat management or restoration (see Recommended Conservation Actions below).
        ii. FWC will implement or oversee implementation of plans on sites where it is the lead according to the MOA to the extent possible given budget and logistical constraints.
    d. Establish and implement a long-term monitoring plan for each population to confirm persistence.

2. **Locate additional extant populations.**
   a. Establish a MOA with the USFWS regarding the role of each agency in coordinating flatwoods salamander surveys on federal, state, local government, and private lands where landowners willingly grant access to their property.
   b. Identify and rank, according to likelihood of occupancy, potential sites where flatwoods salamanders might occur.
   c. Conduct systematic surveys to confirm status on sites of potential occurrence, with highest emphasis on sites where occurrence is most likely.
   d. Manage sites where occupancy is confirmed according to Strategy 1.

3. **Establish flatwoods salamanders (at the number of sites necessary to achieve the population objective) within the historic range of the species where habitat conditions are favorable but salamanders appear to have been extirpated.**
   a. Identify suitable candidate recipient sites, in conjunction with the surveys called for under Strategy 2.
   b. Conduct research at sites currently occupied by populations to identify likely macro- and micro-habitat features necessary for the species to thrive.
   c. Conduct research to identify best options for translocating salamanders for stocking, including identification of best candidate donor sites (using information gathered under Strategy 1).
   d. Evaluate candidate sites according to findings from research under Strategy 3b.
   e. Establish clear numerical objectives by which to evaluate the success of each re-establishment attempt.
   f. Conduct experimental translocations in an adaptive management context, with thorough monitoring relative to the objectives established under Strategy 3e.
   g. Manage sites where establishment is successful under Strategy 1.

Although FWC staff consider Strategy 3, re-establishment of flatwoods salamanders within the historic range, to be a critical component of conservation objective achievement, it should be undertaken with caution. Dodd and Seigel (1991) determined that most relocation, repatriation, and translocation (RRT) projects involving amphibians and reptiles have not proven successful. They warn against undertaking an RRT project unless (1) causes of the species' decline are known and have been eliminated; (2) the species' biological (habitat, demographic, and biophysical) constraints are fully understood; (3) consideration has been given to population genetics, including minimum viable population size, and social structure; and (4) there will be commitment to the long-term monitoring of marked individuals to establish the success or failure of the project.

RECOMMENDED CONSERVATION ACTIONS

Proposed FWC Regulations

The federal listing package for the flatwoods salamander (USFWS 1999) provided guidance on the types of actions that would be considered prohibitions and exceptions (Appendix 5, see also Appendix 6). These federal prohibitions obviate the need to propose many state-level regulations. The FWC considers the following 2 rules sufficient to protect flatwoods salamanders while conservation efforts are underway to secure the species in Florida by (1) providing a legal basis, at the state level, for prosecuting deliberate take of individuals and populations consistent with Florida Statute 372.0725 (killing or wounding of any species designated as Endangered, Threatened, or Species of Special Concern), (2) regulating scientific collecting and research impacts, and (3) discouraging overt commerce.

1. **Listing of the flatwoods salamander, *Ambystoma cingulatum*, as Species of Special Concern.** This rule is the expected outcome of the current listing process.

2. **Prohibition of direct take of the flatwoods salamander, *Ambystoma cingulatum*, except through permit authorized by the executive director or his delegate.** This rule continues the prohibition of direct take automatically imposed in March 2000 when the FWC accepted the flatwoods salamander as a candidate species for listing. It will allow the FWC to maintain oversight on the research and management of the species, and give the FWC dual authority with the USFWS to review any actions that would result in the planned killing or collection of flatwoods salamanders.

Management Actions

Accomplishment of the conservation objective requires wetland and upland flatwoods habitat of sufficient quality, connectivity, and availability to assure long-term survival and adequate distribution of the flatwoods salamander. There may be a variety of ways to attain this desired future condition in different parts of the species' range, depending on the particular history of the land in question and the tools at the disposal of the land manager. The following recommended management actions should be considered part of a land manager's "toolbox" for the maintenance or enhancement of Florida's statewide flatwoods salamander population. Recommended actions can be grouped into 6 categories: (1) inventory of extant populations across the Florida range, (2) maintenance of habitat quality where extant populations are verified, (3) restoration of habitat quality where historic populations no longer occur, (4) maintenance or restoration of landscape-level features, (5) re-establishment or establishment of flatwoods salamander breeding sites and populations, and (6) reduction of the impact of other potential threats.

Implementation of these actions should help secure the long-term survival of the flatwoods salamander in Florida, and result in a stable or increasing Florida population. A sufficient number of healthy, self-sustaining populations (ones using 3 or more breeding sites each) would be maintained or established to exceed the threshold criteria for Species of Special Concern.

1. **Inventory all appropriate habitat to verify known populations and identify previously unknown populations of flatwoods salamanders throughout the species' Florida range.**
   a. Implement surveys and repeat surveys in appropriate potential habitat across North Florida, including counties where not previously recorded.
   b. Establish geographically based conservation units to help guide survey and management efforts; a proposed scheme with 5 such units is presented in Appendix 10.
   c. Prioritize populations on public lands for implementation of management actions.
   d. Prioritize populations on private lands where landowners willingly allow access for implementation of management actions.

2. **Maintain pine flatwoods and savanna habitat where the species currently occurs through application of forestry techniques that are compatible with flatwoods salamander conservation.**
   a. Apply the forestry practice guidelines as outlined in federal listing package (USFWS 1999, Appendix 4).
   b. Maintain the integrity of the native groundcover and the soil through the application of fire and minimal use of soil disturbing techniques near known breeding ponds. As stands of off-site species such as slash pine (although slash or loblolly pine may be appropriate on-site species in some areas) mature, they should be thinned by burning or tree removal to provide an increasingly open condition needed to permit an herbaceous understory. Thinning and harvest should avoid activities that significantly disturb soil layers and subsurface hydrology, or cause soil compaction. After harvest of off-site species, replace with native, expected overstory species, which may be thinned by burning or tree removal as the stands mature.
   c. Apply growing season fire in preference to winter burning for maintenance of native groundcover and hardwood reduction. However, the application of fire in any season, given appropriate moisture regime, is preferable to not burning.
   d. Avoid poisoning of salamanders and their habitat by using only herbicides and other chemicals labeled for use in and around wetlands and that have a low toxicity for fish and wildlife. Foliar spraying, broadcast application, and banded treatments of herbicides, which pose a greater risk than hack-and-squirt and spot-grid applications of being absorbed through the skin of amphibians, should not be used within 1 mile of known breeding ponds between October and April, or when the soil is saturated.
   e. Promote fire in wetlands by avoiding disturbance of the wetland-upland ecotone.

3. **Restore pine flatwoods and savanna habitat, including native groundcover and wetland breeding sites, through habitat restoration, especially through use of growing-season burns (May - September), in areas where flatwoods salamanders used to occur but do not now.**
   a. Restore the integrity of the native groundcover and the soil through the application of fire and minimal use of soil disturbing techniques. Apply growing season fire in preference to winter burning to restore and maintain native groundcover and reduce hardwood encroachment. However, the application of fire in any season, given appropriate moisture regime, is preferable to not burning. When the existing seedbed and the use of fire and other techniques are insufficient to restore native groundcover in disturbed areas, seeds or other stock from local areas and similar soil types should be used to hasten restoration.
   b. Burn through wetlands during the lightning season when they are dry or nearly dry, to promote a graminaceous ecotone, better larval habitat, and reduce acidity from the increasing buildup of peat. Although growing season burns are essential to maintain the natural character of the breeding ponds, initial and occasional winter burning may be required to reduce fuel loads in some areas. Effective restoration may also require the limited use of herbicides (labeled for use in wetlands) or machinery to knock down invading woody shrubs in a manner that will not disrupt the soil structure.
   c. Plant the native, expected species of pine in preference to off-site slash pine or other species at each site. Maintenance of the groundcover and soil is probably more important to salamanders than the identity of the overstory tree species, but it is important that the dominant canopy species be able to carry the fire essential to the habitat's long-term maintenance.
   d. Restore the natural hydrology to disturbed wetlands by removing berms, filling drainage ditches, and eliminating extensive drainage and ditching within 1 square mile of potential, but presently not used, breeding sites. No such restoration should be attempted for active breeding ponds that are successful but "unnatural" (i.e., the wetland has an appropriate hydroperiod due to the presence of ditches and dikes), as long as they continue to be used by flatwoods salamanders.

4. **Maintain or restore the landscape-level features that encourage natural metapopulation processes and genetic diversity and increase the likelihood of long-term survival of flatwoods salamander populations.**
   a. Maintain or restore the integrity of natural vegetation and associated habitats in terrestrial buffer zones to protect breeding sites (ephemeral isolated wetlands).
   b. Protect the integrity of ecological connectivity (i.e., stepping stone ponds with corridors of natural vegetation) among wetlands with a diverse array of hydroperiods in the landscape.

c. Protect ephemeral isolated wetlands of all sizes important for amphibian reproduction. Persistence of wetlands as small as 0.1 ha or less are critical to long-term survival of flatwoods salamanders and other species.
d. Re-establish historic connections among known flatwoods salamander areas with corridors of appropriate habitat to facilitate gene exchange among populations.

5. **Re-establish or establish additional flatwoods salamander breeding sites and populations throughout its Florida range.**
   a. Re-establish extirpated populations in restored, formerly occupied sites, using animals from closest population on that side of Apalachicola River.
   b. Establish new populations in suitable habitat within the extent of occurrence, but where extant populations are not presently known, using animals from closest population on that side of Apalachicola River.

6. **Reduce the impact of other potential threats to flatwoods salamanders.**
   a. Enforce regulations prohibiting trash dumping in or near breeding sites.
   b. Do not allow damaging off-road vehicle use in or near breeding sites.
   c. Reduce road mortality by providing drift fences or similar structures to guide migrating salamanders through appropriate under-road passages to and from breeding ponds.
   d. Explore measures to minimize impact of crayfish harvest on flatwoods salamanders at known breeding sites.
   e. Do not introduce predatory fish into temporary wetlands.

Proposed Incentives for Management Actions on Private Lands

FWC staff investigated potential, existing incentives to promote the voluntary enhancement of flatwoods salamanders populations on private lands.

1. **Seek opportunities to obtain funds and other incentives to help private landowners conserve known or potential flatwoods salamander populations.** The Florida Forestry Stewardship Program or Stewardship Incentive Program (SIP) (Duryea et al. 1992) provides cost-sharing for development of a management plan, soil and water protection and improvement, wildlife habitat enhancement, and other forest management activities. Another program that offers cost-sharing for implementation of Best Management Practices, including enhancement of wildlife habitat, is the Environmental Quality Incentives Program (EQIP) (Olmstead et al. 1997).

2. **Explore adoption of a wildlife stewardship-type program involving flatwoods salamanders.** Such a program could be modeled after Georgia's Forestry for Wildlife

Partnership Program (FWP) (Georgia Department of Natural Resources 1998), which provides public recognition for those corporate forest landowners whose activities promote wildlife conservation, and habitat and species diversity on their lands. This program builds on the Sustainable Forestry Initiative (SFI) established by the American Forest and Paper Association (AF&PA 2000a, 2000b).

3. **Investigate opportunities available to private landowners with flatwoods salamanders to participate in federal incentive programs.** As part of the proposed process to develop a MOA with the USFWS regarding management of salamanders on federal land, the FWC will investigate the availability of federal funds that might be used as incentives for conservation of the species on private lands.

4. **Determine what federal requirements would need to be met to enter into a statewide Habitat Conservation Plan (HCP) for flatwoods salamanders.** Under such a plan, the state would maintain a specified population level of flatwoods salamanders in exchange for the delegation authority to issue permits for take resulting from land use practices.

Monitoring Plan

The success of management actions undertaken for flatwoods salamander conservation can be measured through the periodic monitoring of extant salamander populations, as determined by the location and persistence of active breeding ponds. Due to the relative inconspicuousness of the flatwoods salamander, evaluation of its current status depends on repeated labor-intensive seasonal surveys. Two different types of surveys are used to assess presence of this species: (1) dipnetting for larvae, which are boldly striped and easily recognized, and (2) the capture-mark-recapture of adults, typically using drift fences and traps. Larval dipnetting is less time-consuming and involves less equipment, and is therefore the method better suited for broad scale assessment of flatwoods salamander presence. Use of drift fences is not suited for extensive surveys to determine presence at many different sites, and so is not recommended as a major component of this monitoring plan. However, drift fences and mark-recapture techniques are important research tools to address questions of population size and demography, timing of migration, migration distances, and habitat use.

Successful flatwoods salamander reproduction is greatly influenced by localized weather trends, particularly precipitation. Annual differences in amount or timing of rainfall may determine whether a given pond is used. Some sites that serve as breeding sites 1 year may not have larvae the next (Palis 1993); by the same token, failure to find larvae 1 season is not sufficient evidence to exclude a given pond from the suite of potentially important flatwoods salamander reproductive sites. Therefore, long-term monitoring of the reproductive success at each known breeding pond, as measured by the presence or absence of larvae, is the critical feature of this monitoring plan. The objective of the monitoring plan is to confirm the presence of larvae at least once every 5 years for each population.

The monitoring protocol proposes that 5 consecutive years of sampling without verified larval presence in at least 1 of a population's breeding ponds are required before a population is "written off." A population with verified presence of flatwoods salamanders needs to be monitored a minimum of once every 5 years, more often if changes in land use or other factors raise concerns about salamander persistence at that site. Demonstration that multiple proximal breeding ponds are being used indicates a population with an increased potential for long-term survival; that population might be able to persist even if 1 or more ponds become unsuitable.

Palis and Walker (1993) attempted to develop a standardized dipnetting sampling procedure, based on the number of dipnet sweeps expended before obtaining the first larva, as an index to categorize ponds by relative numbers of larvae. Although their results were not conclusive, it would be useful if breeding ponds eventually could be so ranked. Due to inherent difficulties (e.g., dense vegetation, high water, variations in dipnetting skill) sometimes associated with larval dipnetting, it has been suggested (D. Stevenson pers. commun.) that this technique be supplemented with the use of aquatic funnel trapping (using aluminum funnel traps without bait) and night visits to breeding sites (using flashlight to look for larvae stratifying in the water column) to increase the chances to verify larval presence.

The following variables will be monitored and assessed to detect change in flatwoods salamander population status.

1. **Number of known populations in Florida.** A known population is one where larvae have been verified within the past 5 years. This is the primary variable for assessing the status of the flatwoods salamander.

2. **Number of Florida counties with extant populations.** This is a coarse measure of status. Flatwoods salamanders are historically (pre-1990) known from 17 counties; currently they are known from only 12 counties.

3. **Number of known populations outside of Florida.** Periodic collaboration with other states using similar monitoring efforts for flatwoods salamanders could provide information indicating a change in the species' range-wide status.

If monitoring reveals that the following thresholds have been reached, FWC staff will recommend reassessment of population status.

1. **Verification of 129 or more Florida populations (occupying an area of about 562 square miles), with reproduction verified by the presence of larvae at least once in 5 years**. This would exceed the criteria for Species of Special Concern designation, given the assumption that an average population occupies about 4.36 square miles.

2. **Verification of only 33 or fewer known or potential Florida populations**. This would trigger a re-evaluation of the species' status for possible reclassification to Threatened status (0.73 x 46 populations occupying 200 square miles or less).

3. **Verification of at least 10,000 mature individuals range-wide, or at least 7,300 in Florida** which exceeds the criteria for Species of Special Concern.

4. **Verification of 1,825 or fewer mature individuals**, which may indicate Threatened status (0.73 x 2,500).

5. **Verification of change in status (increase or decrease) in other states**.

Areas for Future Research

There are many facets of flatwoods salamander life history and ecology that remain poorly understood or are as yet unknown. Active pursuit of research on the following topics, and on others as they arise, is critical to our understanding of this species, and the results will help guide and refine recommended management actions.

1. **Salamander Movement and Upland Habitat Use**. Very few data exist on the movement of individual flatwoods salamanders (Appendix 11). This information is critical to demonstrating upland as well as pond use, designation of population size and boundaries (i.e., area of occupancy), determination of potential for gene exchange, and understanding metapopulation processes. As additional movement data are obtained, recommendations for habitat definition and protection may change.

2. **Systematics**. Molecular data support taxonomic splitting of *Ambystoma cingulatum* into 2 well-defined taxa east and west of the Apalachicola River (Pauly et al. 2000). Should further study validate such splitting, conservation actions and listing designations should accommodate all resulting taxa.

3. **Delineation of Microhabitat and Other Aspects Prior to Reintroduction Attempts.** If an insufficient number of extant populations are found to exist in Florida to meet the target conservation objective, attempts will be made to re-establish extirpated populations and/or establish new populations of flatwoods salamander. However, the species' biological (habitat, demographic and biophysical) constraints should be fully understood prior to the initiation of such efforts. Studies that delineate the microhabitat needs of the flatwoods salamander (e.g., soil characteristics, pH, temperature and moisture regimes, herbaceous structure and

component species, prey species abundance and distribution) will enable biologists to identify suitable unoccupied sites or restore potential sites.

4. **Population Size and Demography.** The monitoring plan emphasizes the use of larval dipnetting; however, the number of larvae encountered in a pond gives no indication of how many adults entered the depression to breed (Palis 1997a). Encircling breeding sites with a continuous drift fence and using mark-recapture techniques can provide information on the size of the adult breeding population. This type of study also yields information regarding the timing of migration, migration distances, habitat use, and factors that stimulate breeding. Studies should continue on a long-term basis (e.g., Palis 1997a, Palis and Aresco 2000) throughout the species' range to reveal year-to-year fluctuations. These studies would also provide data on actual reproductive success by censusing emerging metamorphs. These data may be used to derive population viability models for flatwoods salamanders.

ANTICIPATED ECONOMIC AND SOCIAL IMPACTS

The assessment of anticipated economic and social impacts of management plan implementation derives from a consideration of the rules proposed therein and from issues raised during the public comment periods. The rule proposed for FWC action is the addition of the flatwoods salamander to the state Species of Special Concern list with a prohibition on direct take except as authorized by the FWC executive director or his delegate. Eight written comments were received during the flatwoods salamander management plan public comment period concluding November 28, 2000. Technical and scientific comments were considered during plan revision and finalization. Economic and social issues are summarized and addressed below.

Potentially Affected Parties

Private landowners, public land managers, scientific researchers, and citizens of the state of Florida are the potentially affected parties.

Economic Impacts

Estimated cost to FWC of implementing proposed rule.—The proposed rule will necessitate commitment of staff time to review permit applications for executive director consideration and approval. Up to one-half of the full time equivalent of a Biological Scientist III would be required annually to complete this work.

Estimated cost to potentially affected parties of implementing and of not implementing the proposed rule.—Since the proposed rule imposes fewer restrictions on land use than the federal listing of flatwoods salamander as a threatened species (USFWS 1999), and since the state permit required for direct take is a no cost permit, FWC does not anticipate any economic impacts to any affected parties as a result of management plan implementation. If the management plan is not implemented, the potential exists for the flatwoods salamander to become increasingly imperiled. This eventuality could necessitate future imposition of additional, potentially costly, conservation measures.

Summary of public comments.—

Issue 1: Financial incentives must be provided in order for the management plan to be successfully implemented on private lands.

The majority of known flatwoods salamander populations are found on public lands, and the recommended management actions outlined in the FWC management plan are primarily intended as a guide to public lands managers. The FWC supports, in concept, the development of financial incentives for private landowners who voluntarily provide access to their lands for survey and monitoring activities and who manage their properties in such as way as to promote the perpetuation of flatwoods salamander populations. Private landowners participating in the conservation of flatwoods salamanders may be eligible to receive compensation under the auspices of at least 2 established programs: (1) the Florida Forestry Stewardship Program or Stewardship Incentive Program (SIP) (Duryea et al. 1992), which provides cost-sharing for development of a management plan, soil and water protection and improvement, wildlife habitat enhancement, and other forest management activities; and (2) the Environmental Quality Incentives Program (EQIP) (Olmstead et al. 1997), which offers cost-sharing for implementation of Best Management Practices, including enhancement of wildlife habitat.

Issue 2: If county governments incorporate the recommended management actions into their comprehensive plans, possibly making them even more restrictive, the resultant economic impacts on private landowners could be very severe.

The FWC based the recommended management actions presented in this plan upon the best available science. These recommendations are intended to alleviate current range-wide threats to flatwoods salamander sufficiently to secure the population at a level which exceeds the threshold for Species of Special Concern designation and hence warrants removal from the state list. The FWC encourages but does not compel consideration of these recommendations by county governments or other agencies regulating private land use. County governments should solicit public comment and carefully assess the potential economic impacts to local landowners prior to adopting any mandatory land use regulations.

Issue 3: Imposition of this plan in addition to the federal listing restrictions will make it impossible to manage private lands economically.

The only compulsory regulation contained within the flatwoods salamander management plan is the proposed prohibition on direct take, which is far less restrictive than prohibitions currently in place under federal regulations. The FWC intends to pursue negotiations which may lead to the establishment of a statewide Habitat Conservation Plan (HCP) and subsequent issuance of incidental take permits for land management activities on private lands by the USFWS. It should be noted that not all affected parties endorse the development of an HCP for the conservation of flatwoods salamander. The FWC plans to coordinate its activities closely with the USFWS to ensure that an HCP would in fact confer positive progress toward the conservation of flatwoods salamanders.

Social Impacts

None of the public comments specifically identified anticipated social impacts related to implementation of the management plan. The potential for social impacts was always paired with concern for the potential economic cost to private landowners. Nor did any of the public comments specifically identify anticipated social impacts which could result from not implementing the management plan. However, although difficult to quantify, there are uncompensated social costs associated with the decline or loss of a species. These include loss of biological diversity and dwindling genetic resources, loss of individual animals, and concomitant loss of the opportunity to encounter and study the species.

IMPLEMENTATION STRATEGY

The wide array of conservation actions necessary to ensure the long-term survival of the flatwoods salamander requires prioritization. Accomplishment of the conservation objective requires the coordination and cooperation of multiple public and private land managers, each of whom works within various constraints. Proposed budgets, schedules, and tasks have to be feasible for there to be any hope of management action implementation.

Priority Actions

FWC staff identified the following suite of conservation actions as high priority and requiring primary or significant participation by the FWC:

1. **Develop a Memorandum of Agreement with federal land managers**. The flatwoods salamander's federal status as Threatened compels the federal land management agencies on

whose lands it is known to occur (currently 19 of the 38 populations known in Florida occur on federal properties, Appendix 8) to evaluate the potential adverse impacts of their activities on the species. In addition, these federal agencies have funded previous and ongoing surveys to document occurrence of flatwoods salamanders at both known and newly discovered breeding sites. In the interest of monitoring the status of the flatwoods salamander statewide, the FWC would like to enter into a Memorandum of Agreement (MOA) with these federal land managers to keep apprised of their ongoing and planned management activities, to share information about the locations of salamander breeding sites and other localities, and to assist in the development and implementation of joint or complementary survey and monitoring plans.

2. **Coordinate initiation of conservation actions on wildlife management areas.** For all wildlife management areas throughout the flatwoods salamander's extent of occurrence in Florida, including but not limited to those that are known to harbor flatwoods salamanders, FWC staff will assess where potential flatwoods salamander habitat exists and, on those areas, will coordinate with the lead management authority and/or landowner to plan and implement survey, monitoring, management, and research activities to ensure the discovery and long-term survival of all extant populations.

3. **Explore the feasibility for cooperative agreements or conservation easements for long-term management for flatwoods salamanders on private lands.** The FWC will strive to develop positive relationships with private landowners, offering advice and, if available, other resources to support long-term efforts to survey, protect, and manage populations of flatwoods salamanders on their land. Whenever possible, it would be desirable to obtain cooperative agreements or conservation easements for long-term management for flatwoods salamanders on private lands.

4. **Maintain a comprehensive database.** FWC staff will maintain, in collaboration with Florida Natural Areas Inventory, a comprehensive database (Wildlife Occurrence Database or "Wildobs") and maps for flatwoods salamander breeding sites and population designations.

5. **Explore the potential for a Statewide Habitat Conservation Plan (HCP).** The FWC will collaborate with the USFWS to establish what population levels or other parameters of flatwoods salamander conservation in Florida would need to be met in order to set up a statewide Habitat Conservation Plan (HCP) that could serve as the basis for relaxation of federal flatwoods salamander take prohibitions in some situations.

6. **Collaborate with state wildlife agencies in Georgia, South Carolina, and Alabama.** FWC staff will collaborate with state wildlife agencies in Georgia, South Carolina, and Alabama to determine the current status of flatwoods salamanders and to encourage actions to survey, manage, and enhance their populations range-wide.

7. **Prepare a "how-to" pamphlet for land managers.** In coordination with other agencies, FWC staff will assist in the preparation of a "how-to" pamphlet on flatwoods salamander requirements and management for publication on the Internet and hard-copy distribution to applicable landowners and the interested public.

8. **Encourage research.** The FWC will encourage the implementation of research, as described in the section Areas for Future Research.

Budget

The primary budget needs for implementation will be for personnel, equipment, and travel to conduct surveys, meet with public and private landowners, and initiate management actions and research. The full scope of the FWC's commitment will depend partly upon the MOA with the USFWS and the respective role each agency will have in flatwoods salamander conservation. Specific budget needs for each year will be addressed in the FWC's annual operational plan for this project.

Proposed 12-Month Implementation Schedule

Given current FWC staffing and budget appropriations, the following represents a reasonable set of tasks to be completed between March 2001 and March 2002.

1. Implementation of proposed rules for the flatwoods salamander.

2. Development of a MOA with the USFWS to clarify each agency's role in coordinating and monitoring work on existing populations on federal, state, local government, and private lands.

3. Coordination with Florida Natural Areas Inventory and other state and federal agencies to address implementation of the management plan, including available resources and timetables to implement habitat management and restoration, wetlands inventory, statewide surveys and resurveys of known and potential flatwoods salamander populations.

4. January - April 2002 initiation of surveys for larvae at known sites to assess status and standardize survey techniques.

5. Preparation of a threat assessment for all known sites for which FWC assumes management or coordination responsibility via the MOA process. The assessment would include descriptions and cost estimates for survey, monitoring, and management actions for each site.

Scheduled Review and Revision of Species Management Plan

In order to ensure steady progress toward the conservation objective, FWC staff will regularly review and assess the assumptions and recommended actions outlined in the management plan in light of newly available data as follows: (1) survey data (including primarily dipnet surveys, perhaps some drift fence and road-cruise data) will be reviewed at the end of each field season (May-June) to revise the tally of known populations, and their distribution across counties and geographic regions; (2) reassessment of population status with respect to population status thresholds in the management plan could occur annually for extent of occurrence and area of occupancy, and every 3-5 years for perceived population trends; (3) accumulation of sufficient data to warrant petition for change in listing status is expected to take a minimum of 5 years so formal reassessment of Florida population status should be scheduled for year 5 to delete those populations with no verified presence in the preceding 5 years of monitoring and to add newly confirmed populations; (4) dramatic changes observed in species status (sudden decline due to environmental catastrophe, increase due to discovery of many previously unknown populations) could trigger immediate revision of management plan or petition for change in listing status.

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APPENDIX 1. Procedures for Listing, Delisting and Reclassifying Endangered, Threatened and Species of Special Concern

Rule 68A-27.0012, Florida Administrative Code (F.A.C.)

(1) Petition to list, delist, or reclassify a species in Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C.
   (a) Persons wishing to add, delete or reclassify species in Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C., shall submit a written petition to the Commission.
      1. Petitions shall be clearly identified as such, and must contain the following in order to be considered complete:
         a. The rule to which the species is proposed to be added, removed from or reclassified to,
         b. The name, address and signature of the petitioner, and
         c. Sufficient information on the biology and distribution of the species to warrant investigation of its status using the criteria contained in definitions of endangered, threatened or species of special concern in Rule 68A-1.004, F.A.C.
   (b) Incomplete petitions will be returned to the petitioner with insufficiencies clearly noted in writing. Corrected petitions may be resubmitted for consideration.
   (c) Complete petitions will be evaluated in accordance with the provisions in subsection (2).
   (d) If, in the opinion of the Executive Director, immediate inclusion of a species in Rule 68A-27.003(1), F.A.C., is essential to prevent imminent extinction, such listing may be effected on a temporary basis not to exceed 240 days. Such emergency listings shall be approved by the Commission at the next scheduled meeting. The Commission shall conduct the evaluations prescribed in (2) and (3) of this subsection to determine the appropriate final classification of the species.
(2) Review of petitions to determine biological status; Phase 1.
   (a) The Commission shall establish a deadline for completion of the biological review of each complete petition.
   (b) The Commission shall provide notice by mail to parties who request such notification and shall publish in the Florida Administrative Weekly a solicitation of information on the biological status of the petitioned species. Written comments regarding biological status shall be accepted by the Commission for a period of no less than 45 days following public notice.
   (c) The Commission shall summarize information provided in the petition, information obtained from the public and other available biological data on status of the petitioned species into a preliminary biological status report. The preliminary biological status report shall contain a recommended classification for the petitioned species consistent with the available biological data and based on the criteria established in 68A-1.004, F.A.C.
   (d) The Commission shall designate a biological review panel with a minimum of three scientists with demonstrated knowledge and expertise pertaining to species conservation and

management. This panel shall independently evaluate information compiled on the petitioned species' biological status relative to its proposed classification in Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C.

(e) The biological status report and the information referenced in subparagraph (c) shall be provided to members of the panel of scientific experts for the review mandated in (d) of this subsection. Panel members shall have no fewer than 45 days to review the document and provide recommendations to the Commission.

(f) The Commission shall consider the final biological status report, biological recommendations from the panel of scientific experts and public testimony regarding biological status in making a final determination whether addition, deletion or reclassification of the petitioned species in Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C., is warranted.

(g) If the petitioned species is determined by the Commission to warrant inclusion in Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C., the Commission shall:

1. Specify the appropriate listing category for the species based on biological status.
2. Establish a deadline for completion of Phase 2 for the species as described in subsection (3) below, considering the recommendation of Commission employees and other interested parties.
3. If the species is not already listed in Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C., it shall be added to the list of candidate species in Rule 68A-27.0021, F.A.C., and the protective provisions therein shall apply to the species.

(3) Development of management plans, regulations, permit requirements for candidate species; Phase 2.

(a) Within 45 days following designation of a candidate species, the Commission shall provide notice by mail to parties who request such notification and shall publish in the Florida Administrative Weekly a solicitation of information on the conservation needs of the species, and any economic and social factors that should be considered in its management.

(b) The Commission shall use information obtained from the public and other available information to develop a draft management plan for each candidate species that addresses:

1. Biological status as determined in Phase 1,
2. Conservation objectives,
3. Recommended management actions,
4. Recommended Commission regulations and incentives,
5. Anticipated economic and social impacts of implementing or not implementing the recommended conservation actions.

(c) The Commission shall provide notice by mail to parties who request such notification and shall publish in the Florida Administrative Weekly a notice of the availability of the draft management plan. Written comments regarding conservation recommendations and expected economic and social impacts of implementation of the management plan shall be accepted by the Commission for a period of no less than 45 days following public notice.

(d) Final Commission action on the petition shall include:

1. Deletion of the species from 68A-27.0021 if appropriate, and addition to and/or deletion from Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C., in accordance with the determination made in (2) of this subsection.
2. A determination on any proposed regulations in the management plan.

Specific Authority Art. IV, Sec. 9, Fla. Const.
Law Implemented Art. IV, Sec. 9, Fla. Const.
History--New 6-23-99, Formerly 39-27.0012.

APPENDIX 2. Definitions of the Florida Fish and Wildlife Conservation Commission Relative to Listed Species

Rule 68A-1.004, Florida Administrative Code (F.A.C.)

The following definitions are for the purpose of carrying out the provisions of the rules of the Fish and Wildlife Conservation Commission relating to wild animal life and freshwater aquatic life. As used herein, the singular includes the plural. The following shall be construed respectively to mean:

(18) Candidate species — A species, subspecies, or isolated population of a species or subspecies, which has been determined by the Commission to warrant listing under Rules 68A-27.003, 68A-27.004 or 68A-27.005, F.A.C., but for which actual listing in the aforementioned rules is pending development of a management plan.

(25) Direct take — Intentionally pursuing, hunting, capturing, killing, or destroying fish or wildlife or the nests, eggs, homes or dens of fish or wildlife.

(26) Endangered species — As designated by the Commission, a species, subspecies, or isolated population of a species or subspecies which is so few or depleted in number or so restricted in range or habitat due to any man-made or natural factors that it is in imminent danger of extinction as determined by (a), (b), (c), (d) or (e) below:

(a) Population reduction in the form of either:
   1. An observed, estimated, inferred or suspected reduction of at least 80% over the previous ten years or three generations, whichever is longer, based on, and specifying, any of the following:
      a. Direct observation
      b. An index of abundance appropriate for the species
      c. A decline in area of occupancy, extent of occurrence or quality of habitat
      d. Actual or potential levels of exploitation
      e. The effects of introduced species, hybridization, pathogens, pollutants, competitors or parasites
   2. A reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is longer, based on, and specifying, any of 1.b., 1.c., 1.d. or 1.e. above.

(b) Extent of occurrence estimated to be less than 40 square miles or area of occupancy estimated to be less than 4 square miles, and estimates indicating any two of the following:
   1. Severity fragmented or known to exist at only a single location.
   2. Continuing decline, observed, inferred or projected, in any of the following:
      a. Extent of occurrence

b. Area of occupancy
c. Area, extent and/or quality of habitat
d. Number of locations or subpopulations
e. Number of mature individuals

3. Extreme fluctuations in any of the following:
a. Extent of occurrence
b. Area of occupancy
c. Number of locations or subpopulations
d. Number of mature individuals

(c) Population estimated to number fewer than 250 mature individuals and either:
1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, or
2. A continuing decline, observed, projected or inferred, in numbers of mature individuals and population structure in the form of either:
a. Severe fragmentation (that is, no subpopulation estimated to contain more than 50 mature individuals).
b. All individuals are in a single subpopulation.

(d) Population estimated to number less than 50 mature individuals.

(e) Quantitative analysis showing the probability of extinction in the wild is at least 50% within ten years or three generations, whichever is longer.

(73) Species of special concern — As designated by the Commission, a species, subspecies, or isolated population of a species or subspecies which is facing a moderate risk of extinction in the future, as determined by (a), (b), (c), (d) or (e) below:

(a) Population reduction in the form of either:
1. An observed, estimated, inferred or suspected reduction of at least 20% over the last ten years or three generations, whichever is longer, based on, and specifying, any of the following:
a. Direct observation
b. An index of abundance appropriate for the species
c. A decline in area of occupancy, extent of occurrence and/or quality of habitat
d. Actual or potential levels of exploitation
e. The effects of introduced species, hybridization, pathogens, pollutants, competitors or parasites
2. A reduction of at least 20%, projected or suspected to be met within the next ten years or three generations, whichever is longer, based on, and specifying, any of 1.b., 1.c., 1.d. or 1.e. above.

(b) Extent of occurrence estimated to be less than 7,700 square miles or area of occupancy estimated to be less than 770 square miles, and estimates indicating any two of the following:
1. Severely fragmented or known to exist at only a single location.

2. Continuing decline, observed, inferred or projected, in any of the following:
    a. Extent of occurrence
    b. Area of occupancy
    c. Area, extent and/or quality of habitat
    d. Number of locations or subpopulations
    e. Number of mature individuals
3. Extreme fluctuations in any of the following:
    a. Extent of occurrence
    b. Area of occupancy
    c. Number of locations or subpopulations
    d. Number of mature individuals

(c) Population estimated to number fewer than 10,000 mature individuals and either:
1. An estimated continuing decline of at least 10% within ten years or three generations, whichever is longer; or
2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:
    a. Severely fragmented (i.e., no subpopulation estimated to contain more than 1,000 mature individuals).
    b. All individuals are in a single subpopulation.

(d) Population very small or restricted in the form of either of the following:
1. Population estimated to number fewer than 1,000 mature individuals
2. Population is characterized by an acute restriction in its area of occupancy (less than 40 square miles) or in the number of locations (fewer than 5)

(e) Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

(77) Threatened species — As designated by the Commission, a species, subspecies, or isolated population of a species or subspecies which is facing a very high risk of extinction in the future, as determined by (a), (b), (c), (d) or (e) below:

(a) Population reduction in the form of either of the following:
1. An observed, estimated, inferred, or suspected reduction of at least 50% over the last ten years or three generations, whichever is longer, based on, and specifying, any of the following:
    a. Direct observation
    b. An index of abundance appropriate for the species
    c. A decline in area of occupancy, extent of occurrence and/or quality of habitat
    d. Actual or potential levels of exploitation
    e. The effects of introduced species, hybridization, pathogens, pollutants, competitors or parasites

2. A reduction of at least 50%, projected or suspected to be met within the next ten years or three generations, whichever is longer, based on, and specifying, any of 1.b., 1.c., 1.d. or 1.e. above.

(b) Extent of occurrence estimated to be less than 2,000 square miles or area of occupancy estimated to be less than 200 square miles, and estimates indicating any two of the following:
   1. Severely fragmented or known to exist at no more than five locations
   2. Continuing decline, observed, inferred or projected, in any of the following:
      a. Extent of occurrence
      b. Area of occupancy
      c. Area, extent and/or quality of habitat
      d. Number of locations or subpopulations
      e. Number of mature individuals
   3. Extreme fluctuations in any of the following:
      a. Extent of occurrence
      b. Area of occupancy
      c. Number of locations or subpopulations
      d. Number of mature individuals

(c) Population estimated to number fewer than 2,500 mature individuals and either:
   1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer; or
   2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:
      a. Severely fragmented (i.e., no subpopulation estimated to contain more than 250 mature individuals)
      b. All individuals are in a single subpopulation.

(d) Population estimated to number fewer than 250 mature individuals.

(e) Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is longer.

APPENDIX 3. Petition to List the Flatwoods Salamander (*Ambystoma cingulatum*) on the State of Florida Threatened Species List

Introduction

By this petition, the Florida Fish and Wildlife Conservation Commission (FWC) is requested to list the flatwoods salamander (*Ambystoma cingulatum*) as a threatened species in the State of Florida (Rule 39-27.004, Florida Administrative Code). This action is warranted because of population declines due to decreases in population numbers, area of occupancy, extent of occurrence, and quality of habitat.

This petition is in response to the recent U.S. Fish and Wildlife Service final rule action adding the flatwoods salamander to the federal List of Endangered and Threatened Wildlife as a threatened species under the authority of the Endangered Species Act of 1973, as amended.

Biological Information

The U.S. Fish and Wildlife Service undertook an extensive review of the biological status of the flatwoods salamander in response to a petition to list the salamander as endangered or threatened. Much of that information was published in the Federal Register (LaClaire 1999) as part of the final rule action listing the salamander as threatened. That information is the basis for this petition, and the final rule as published in the Federal Register is included as an appendix to this petition. Following is a brief summary of the information presented in the USFWS final rule. The final rule information included addresses for obtaining the source information.

The flatwoods salamander occurs in isolated populations in pine flatwoods habitats of the lower Coastal Plain of South Carolina, Georgia, and Florida. Most known populations are in Florida. The primary threat to this salamander is the loss of flatwoods habitat and the isolated, seasonal ponds within the flatwoods required for breeding. Conversion of flatwoods to pine plantations, other agriculture, and urban development have eliminated as much as 80% of originally occurring flatwoods, and loss of flatwoods habitat is continuing. At present rates of loss, nearly all natural flatwoods in Florida will be destroyed within 25 years.

LaClaire (1999) noted that recent surveys had found flatwoods salamanders at only eight percent (8%) of 1,303 potential sites surveyed throughout the species' range. In Florida, 530 sites considered potential flatwoods salamander habitat were surveyed. Salamanders were found at only 15% of the sites.

Additionally, clear-cut harvesting and forest management activities commonly used on pine forests contribute to the degradation of flatwoods salamander habitat. Activities such as soil-disturbing site preparation, lower fire frequencies, high seedling stocking rates, and use of herbicides result in a forest that is not favorable for flatwoods salamanders. Wetland breeding sites are degraded by such practices as ditching ponds, harvesting cypress, and using ponds for slash disposition or firebreaks.

Loss of flatwoods habitat and the isolated seasonal ponds within flatwoods due to conversions to other uses, silvicultural practices, and altered fire cycles have significantly reduced the number of flatwoods salamanders and their area of occupancy, extent of occurrence, and the quality of habitat the salamander requires. Remaining populations of flatwoods salamanders are likely to decline in numbers and extent as suitable habitat continues to be destroyed or degraded, and the USFWS concluded the species was likely to become endangered in the foreseeable future if no actions were taken to change the current situation. Based upon the information presented in the USFWS final rule, the flatwoods salamander meets several of the criteria of a threatened species as defined in Rule 39-1.004 and, therefore, should be added to the State of Florida Threatened Species List.

Literature Cited

LaClaire, L. V. 1999. Endangered and threatened wildlife and plants; final rule to list the flatwoods salamander as a threatened species. Federal Register 64:15691-15704.

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APPENDIX 4. Final Biological Status Report

INTRODUCTION

The U.S. Fish and Wildlife Service ([USFWS] 1999) listed the flatwoods salamander (*Ambystoma cingulatum*) as threatened effective May 3, 1999, under provisions of the Endangered Species Act of 1973, as amended. This listing prompted Fish and Wildlife Conservation Commission (FWC) staff to develop a petition to list the flatwoods salamander as a threatened species in Florida under rule 68A-27.004, Florida Administrative Code (F.A.C.). The following assessment is intended to evaluate the status of the flatwoods salamander in Florida under the criteria embodied in rule 68A-1.004 F.A.C. In order to warrant inclusion on a state list as an endangered species, threatened species, or species of special concern, the flatwoods salamander, on a range-wide scale, must meet at least one of the criteria in 68A-1.004 F.A.C. for one of the listing categories. Because the vast majority of the flatwoods salamander's extant range and populations are in Florida (USFWS 1999), status considerations are not greatly affected by data from other portions of the range. Accordingly, herein we focus on the species' status in Florida.

BIOLOGICAL INFORMATION

Population reduction

No data exist to evaluate numerical population change during the recent 10-year period. However, Palis (1997b) revisited 31 (70.5%) of 44 Florida sites from which flatwoods salamanders had been collected over a period of approximately 50 years prior to 1990. The 13 sites he did not include in his survey were either inaccessible or could not be located based on the available locality data. Palis was able to confirm occurrence at only 11 (35.5%) of these historic collection localities. These data suggest a possible occurrence decline of 64.5% during the 50-year period.

Means et al. (1996) and Palis (1997b) have suggested that flatwoods salamanders may be adversely affected by intensive silvicultural activities. Means et al. (1996) reported an estimated 98% decline in a resident flatwoods salamander metapopulation on private lands adjacent to Apalachicola National Forest following bedding and conversion of the area to slash pine plantation. The USFWS (1999) indicated that more than 80% of the original pine flatwoods habitat within the range of the flatwoods salamander has been lost due to agriculture, urbanization, and silvicultural practices, but no figures were provided specifically for Florida. A similar 60-80% decline in flatwoods habitat in Florida could infer a similar 60-80% long-term reduction in flatwoods salamander populations. Data from a forest industry survey suggest that this inference is not unreasonable. Wigley et al. (1998) sampled 444

ponds on industrial forest lands in south Alabama, south Georgia, and north Florida but found flatwoods salamanders at only 3 ponds (all in Florida).

Ongoing habitat conversion and degradation would have been anticipated to result in a minimum 20% reduction within the next 10 years in area of occupancy, habitat availability, and habitat quality prior to federal threatened listing (USFWS 1999) of the flatwoods salamander. It is difficult to assess the effect that federal listing will have on reducing rates of habitat conversion and degradation. Conversion of flatwoods to pine plantation may be slowed, but habitat degradation will likely continue.

Conversion of mesic pine flatwoods to slash pine plantations on private lands has occurred steadily during recent decades. It is likely that the flatwoods salamander has sustained a decline in habitat availability or quality in the last 10 years at least as great as the 20% required for listing as a species of special concern. It is not likely that the flatwoods salamander has sustained a decline as great as the 50% required for listing as threatened. Therefore, under this criterion listing the species as a species of special concern is supported.

Distribution

Palis (1997b) reported the occurrence of 33 known breeding populations of flatwoods salamanders in Florida. Twenty-four (73%) of these were believed to be restricted to single breeding ponds isolated by at least 3.2 km (2 mi) from any other breeding site. Only Liberty County (Apalachicola Ranger District, Apalachicola National Forest [NF]) and southern Okaloosa County (Eglin Air Force Base [AFB]) are known to support populations with more than 3 available breeding sites. Overall, populations are severely fragmented in Florida, although large metapopulations occur on Apalachicola NF and Eglin AFB.

The Florida distribution of the flatwoods salamander includes 2 separate regions, a northeastern and a western (Palis 1997a, Petranka 1998). The northeastern region includes Alachua, Baker, Bradford, Duval, and Marion counties. Flatwoods salamanders were historically known (prior to 1990) from 10 identifiable localities in this northeastern region, but Palis (1997b) was unable to confirm occurrence at any of these 10 sites. Palis did identify a single population with three breeding sites in Osceola NF, Baker County. This is the only known, remaining population in the northeast Florida region and it likely occupies no more than 5 square miles.

The western region includes the Panhandle from southern Jefferson County west to Escambia County (Palis 1997a, Means 1998). Flatwoods salamanders have been reported from 13 counties within this region. Palis (1997b) was unable to confirm the occurrence of flatwoods salamanders in Escambia County, but the species is known to still occur in at least one locality in each of the remaining western counties from which the species has been reported. This western region covers a total area greater than 2000 square miles but less than 5000 square miles. Thus, the flatwoods salamander's

extent of occurrence exceeds the threshold for threatened classification (<2000 square miles) but falls within the criteria for listing as a species of special concern (2000-7700 square miles).

The flatwoods salamander appears to have been extirpated from most of its former range in northeast Florida. The species also appears to have been extirpated from Escambia County in the Panhandle, and many historic sites in Calhoun and Jackson counties are believed to no longer support flatwoods salamanders. Continuing declines in habitat availability and quality will likely continue to reduce the area of occupancy, the number of occupied locations, and the number of mature individuals throughout the current range.

Mobility of flatwoods salamanders is low, and they have little capacity for naturally recolonizing sites from which they have been extirpated. Trends in extent of occurrence, area of occupancy, habitat quality, and number of subpopulations are likely to continue downward. Numbers of mature individuals likely fluctuate greatly, but this is normal for amphibian populations.

The flatwoods salamander=s current extent of occurrence, fragmented occurrences, and declining extent of occurrence, area of occupancy, habitat availability, and habitat quality meet the criteria to list the salamander as a species of special concern.

Population size and trend

It is very difficult to estimate the total Florida population of the flatwoods salamander. Palis (1997b) estimated that Florida supports a minimum of 33 breeding populations, with a minimum total of 82 breeding ponds. Palis also estimated that 24 (73%) of the 33 populations were restricted to single breeding ponds. Numbers at many of these sites are likely small. One population on Eglin AFB, on the other hand, utilized 21 breeding ponds, and 2 populations on Apalachicola NF each utilized 10 breeding ponds. Each of these 3 populations likely includes at least 1000 mature individuals.

Most amphibian populations are thought to fluctuate greatly over time as a function of fluctuations in volume and timing of rainfall and the associated effects on reproductive success, although no specific information is available for flatwoods salamanders. Palis (1997a) sampled one pond for 2 years and caught 198 salamanders the first year but only 59 the second.

It is reasonable to conclude by extrapolation from the available quantitative data that the total population of mature individuals for known sites certainly exceeds 2500 individuals and, therefore, does not support listing the salamander as threatened. However, the available data indicate that the total population of mature individuals is likely less than the 10,000 individuals required for listing as a species of special concern. Additionally, populations in Florida have likely declined, based on considerations discussed in the previous section, by at least the 10% over the last 10 years that also is required for

listing as a species of special concern. Therefore, the population size criterion for listing the species as a species of special concern appears to be met.

Quantitative analyses

Available data are not sufficient to permit estimation or modeling of the probability of extinction of flatwoods salamanders in the wild.

BIOLOGICAL REVIEW PANEL

A preliminary biological status report with a staff recommendation to list the flatwoods salamander as a species of special concern and the information used to develop that report and recommendation were evaluated by a biological review panel. This panel was appointed by the Florida Fish and Wildlife Conservation Commission at its October 1999 meeting, and was composed of the current chairmen and co-chairmen (or their designees if the chair or co-chair were FWC employees) of the Florida Committee on Rare and Endangered Plants and Animals special committees on fishes, amphibians and reptiles, invertebrates, and birds. Only one of the two co-chairmen of the bird subcommittee was included on the panel. The chairman of the mammal subcommittee withdrew from the panel after appointment. The remaining panel members independently evaluated the preliminary report and information.

Two of the panel members supported the staff recommendation to list the flatwoods salamander as a species of special concern. One of these indicated he also could argue that the species be listed as threatened.

Three of the panel members indicated that they believe the flatwoods salamander should be listed as threatened. However, none of these panel members provided information indicating that the salamander better met the criteria for listing as threatened rather than that for listing as a species of special concern. One panel member indicated that there was little evidence to differentiate between a recent 50% population decline (a threatened criteria) and a recent 20 % decline (a species of special concern criteria). The remaining arguments for listing as threatened were based on experience and philosophies rather than application of the criteria as they are currently defined in Rule 68A-1.004, F.A.C. Therefore, staff did not alter the recommendation to list the flatwoods salamander as a species of special concern initially made in the preliminary biological status report.

PUBLIC COMMENTS ON BIOLOGICAL STATUS

One public comment on the biological status of the flatwoods salamander was received in response to a notice published in the Florida Administrative Weekly (Volume 25, Number 42:4898) on October 22, 1999. This comment suggested there were gaps in the available data regarding flatwoods salamander populations and population trends, and that further inquiry is needed to determine the need for a listing action. FWC staff reviewed the comment and agreed there are some data gaps. However, staff concluded that there was enough credible information to evaluate the biological status of the flatwoods salamander according to the criteria defined for endangered species, threatened species, and species of special concern in Rule 68A-1.004, F.A.C., and that the information presented in the comment was not sufficient to warrant altering the recommendation to list the flatwoods salamander as a species of special concern initially made in the preliminary biological status report.

CONCLUSIONS

The flatwoods salamander was federally listed as threatened in May 1999. As a result, the FWC initiated a petition to list the salamander as threatened in Florida under Rule 68A- 27.004 F.A.C. In order to warrant listing, the flatwoods salamander must meet at least one of the listing criteria in rule 68A-1.004 F.A.C. for a listing category. The flatwoods salamander does not meet any of the criteria established by the FWC for being listed as threatened, as those criteria are currently defined. However, it does meet several of the criteria for listing as a species of special concern. Therefore, staff recommend that the FWC list the flatwoods salamander as a species of special concern under Rule 68A-27.005 F.A.C.

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APPENDIX 5. Federal Permitted and Non-permitted Actions for Flatwoods Salamanders from Federal Listing Packet

The following are verbatim excerpts from the federal listing notice (USFWS 1999) that officially lists the flatwoods salamander as a federally threatened species.

List of actions that "are not likely to result in a violation of section 9, provided these activities are carried out in accordance with existing regulations and permit requirements" (USFWS 1999, p.15703):

1. Possession of legally acquired flatwoods salamanders
2. Lawful hunting activities
3. Lawful burning of habitat where the flatwoods salamander is known to occur, including winter burning
4. Federally approved projects that involve activities such as discharge of fill material, draining, ditching, tilling, bedding, diversion or alteration of surface or ground water flow into or out of a wetland (i.e., due to roads, impoundments, discharge pipes, etc.), when you conduct the activity in accordance with any reasonable and prudent measures given by the Service in accordance with section 7 of the Act
5. Conversion of pine flatwoods habitat where the flatwoods salamander does not occur
6. Timber harvesting in pine flatwoods habitat within a 450-m (1,476-ft) radius buffer zone surrounding a known flatwoods salamander breeding pond, in accordance with the following guidelines:
    a. Use selective harvest, only during dry periods and at a minimum of 10-year intervals, within an inner primary zone extending 164 m (538 ft) out from the edge of the breeding pond. Maintain a basal area of 4.2 to 4.7 square meters (sq m) per ha (45 to 50 square feet (sq ft) per ac) in the primary zone
    b. Use a mix of clear-cutting and selective harvest, only during dry periods and at a minimum of 10-year intervals, in an outer secondary zone extending from 164 m (538 ft) to 450 m (1,476 ft) out from the edge of the breeding pond. Clear-cut up to 25 percent of this secondary zone at any given time, as long as you maintain 75 percent of the secondary zone in pine flatwoods habitat at a basal area of 4.2 to 4.7 sq m per ha (45-50 sq ft per ac). Do not separate the primary and secondary zone from each other by cleared or inappropriate habitat (e.g., non-pine flatwoods habitat such as agriculture, urban development or other forest types).
    c. Minimize skid trails and their effects through the use of prescription planning and techniques such as pallets and bridges. Locate skid trails parallel to, rather than perpendicular to, the wetland edge to reduce alterations in wetland hydrology. Locate all log landings outside the primary and secondary zones.

d. Keep soil disturbance to a minimum. Do not conduct intensive mechanical site preparation (i.e., root-raking, discing, stumping, bedding) or any other actions that cause significant soil disturbance.
e. Prescribed fire should be the preferred method for site preparation and control of woody vegetation. Limit herbicide use to manual application, following BMPs, when fire cannot be employed.

7. Timber harvesting (including clear-cutting) in pine flatwoods habitat where the flatwoods salamander does not occur or outside the 450-m (1,476-ft) buffer zone described above
8. Bait harvesting for crayfish in ephemeral ponds

List of activities that would "be likely to result in a violation of section 9; however, possible violations are not limited to these actions alone" (USFWS 1999, p.15703):

1. Unauthorized collecting, handling, or harassing of individual flatwoods salamanders;
2. Possessing, selling, transporting, or shipping illegally taken flatwoods salamanders;
3. Unauthorized destruction or alteration of wetlands used as breeding sites by flatwoods salamanders. These actions would include discharge of fill material, draining, ditching, tilling, bedding, clear-cutting within the wetland, diversion or alteration of surface or ground water flow into or out of a wetland (i.e., due to roads, impoundments, discharge pipes, etc.), and operation of any vehicles within the wetland;
4. Discharge or dumping of toxic chemicals, silt, or other pollutants (i.e., sewage, oil, and gasoline) into isolated wetlands or upland habitats supporting the species;
5. Unlawful destruction or alteration of suitable pine flatwoods habitat within a 450-m (1,476-ft) radius surrounding a known flatwoods salamander breeding pond. These actions would include, but are not limited to, conversion of habitat to agricultural or urban use, or ditching and draining a site; and
6. Use of pesticides or herbicides in violation of label restrictions.

APPENDIX 6. Federal Prohibitions and Exceptions for Flatwoods Salamanders from Federal Listing Packet

The following are verbatim excerpts from the federal listing notice (USFWS 1999) that officially lists the flatwoods salamander as a federally threatened species.

Prohibitions (USFWS 1999, p.15703):

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all threatened wildlife. The prohibitions, codified at 50 CFR 17.31 for threatened wildlife, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to agents of the Service and State conservation agencies.

Exceptions (USFWS 1999, p.15703):

We may issue permits to carry out otherwise prohibited activities involving threatened wildlife species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.31 for threatened species. You may obtain permits for scientific purposes, to enhance the propagation or survival of the species, and/or incidental take in connection with otherwise lawful activities. For threatened species, you may also obtain permits for zoological exhibition, educational purposes, or special purposes consistent with the purposes of the Act.

APPENDIX 7. Recent Flatwoods Salamander Sites in Florida

County[a]	Palis (1997b) [b]Historic (H); extant sites[c] (populations)	Cox and Kautz (2000) FNAI occurrence records	LaClaire (2000)[d] extant sites[c]; populations (public land/private land)
Escambia	2 H	1	–
Santa Rosa	3 H; 5 sites (3 pops.)	7	9 (3 public/6 private) sites; 2/5[e] pops.
Okaloosa	24 (2 pops.)	2	24 (24/0); 2/0 pops.
Walton	1 (1 pop.)	1	2 (1/1); 1/1 pops.
Holmes	1 (1 pop.)	1	1 (0/1); 0/1 pop.
Washington	1 H; 3 (2 pops.)	4	3 (½); ½ pops.
Bay			
Jackson	7 H; 3 (3 pops.)	6	3 (0/3); 0/3 pops.
Calhoun	6 H; 4 (4 pops.)	6	4 (0/4); 0/3 pops.
Gulf	1 H	1	–
Gadsden			
Liberty	11 H; 36 (14 pops.)	12	33 (33/0); 11/0 pops.
Franklin	2 H; 1 (1 pop.)	3	2 (2/0); 2/0 pops.
Leon			
Wakulla	1 H; 1 (1 pop.)	2	3 (2/1); 2/1[e] pops.
Jefferson		1	1 (0/1); 0/1 pop.
Madison			
Taylor			
Hamilton			
Suwannee			
Lafayette			
Dixie			
Columbia			
Gilchrist			
Levy			
Citrus			
Baker	1 H; 3 (1 pop.)	2	4 (3/1); 1/1 pops.
Union			
Bradford	2 H	1	–
Alachua	4 H	4	–
Marion	1 H	1	–
Nassau			
Duval	2 H	2	–
Clay			
Putnam			
St. Johns			
Flagler			
Volusia			
TOTALS	44 H; 82 (33 pops.)	57 records	89 (69/20); 22/18[e] pops.

[a]all 38 North Florida counties shown on Palis (1997b) map are listed, in approximate west to east and north to south order
[b]defined as pre-1990 records
[c]sites are occurrence records for salamanders, most but not all of which are at breeding ponds
[d]USFWS records, current as of November 6, 2000 (L. LaClaire pers. commun.)
[e]total number of populations is 38; 1 population each in Santa Rosa and Wakulla counties is distributed on both public and private land

APPENDIX 8. Distribution of Extant Flatwoods Salamander Sites in Florida, by Public Versus Private Ownership and County[a]

PUBLIC LAND

Federal/US Forest Service

- **Apalachicola National Forest** (Liberty Co.: 33 sites[b] in 11 populations)
  Apalachicola National Forest (Franklin Co.: 1 site in 1 population)
- **Osceola National Forest** (Baker Co.: 3 sites in 1 population)

Federal/US Department of Defense:

- **Eglin Air Force Base** (Okaloosa Co.: 24 sites in 2 populations)
- **Hurlburt Field** (Santa Rosa Co.: 1 site in 1 population)
- **Holley OLF** (Santa Rosa Co.: 1 site in 1 population)

Federal/US Fish and Wildlife Service

- **St. Marks National Wildlife Refuge** (Wakulla Co.: 2 sites in 2 populations)

State of Florida/DACS/Division of Forestry:

- **Pine Log State Forest** (Washington Co.: 1 site in 1 population)
- **Point Washington State Forest** (Walton Co.: 1 site in 1 population)
- **Tate's Hell State Forest** (Franklin Co.: 1 site in 1 population)

PRIVATE LAND (by county)

- **Baker** (1 site in 1 population)
- **Calhoun** (4 sites in 3 populations)
- **Holmes** (1 site in 1 population)
- **Jackson** (3 sites in 3 populations)
- **Jefferson** (1 site in 1 population)
- **Santa Rosa** (6 sites in 5 populations, 1 of which is shared by public land)
- **Wakulla** (1 site in 1 population that is shared by public land)
- **Walton** (1 site in 1 population)
- **Washington** (2 sites in 2 populations)

[a]From US Fish and Wildlife Service records, current as of November 6, 2000 (L. LaClaire pers. commun.)

[b]sites are occurrence records for salamanders, most but not all of which are at breeding ponds

APPENDIX 9. Derivation of the Conservation Objective

FWC staff arrived at the proposed conservation objective after careful consideration of the Species of Special Concern listing criteria. To be considered a Species of Special Concern, a species needs to meet only 1 of the 5 alternative criteria, listed as (a) through (e) in Appendix 2. However, to exceed the threshold for designation as a Species of Special Concern, it would have to be ascertained that the flatwoods salamander met or exceeded all of the criteria. Discussion of the scientific basis for this approach and its feasibility is presented with respect to each of the 5 listing criteria (numbers 1 through 5 below correspond to (a) through (e) in Appendix 2).

1. **A population reduction of less than 20% either over the last 10 years or projected within the next 10 years.** The Final Biological Status Report emphasized that, although data on population numbers for flatwoods salamanders are lacking, there is a suspected decline in area of occupancy, extent of occurrence and/or quality of habitat that could be inferred from apparent loss of flatwoods habitat. Moreover, prior to the federal listing (USFWS 1999), the trend in habitat conversion and degradation would have been anticipated to result in a decline of at least 20%. If it could be demonstrated that quality flatwoods habitat available to flatwoods salamanders is stable or increasing such that known population numbers are stable or increasing, Species of Special Concern status could be exceeded for this criterion.

2. **Distribution.** This criterion has both a numerical, area-based, component and a distribution component. The alternative (i.e., only one or the other needs to be achieved) numerical components, extent of occurrence and area of occupancy estimates, are considered separately under 2a and 2b below. The distribution component requires estimates that indicate 2 out of 3 additional measures: **severely fragmented** or known to exist at only a single location, **continuing decline** in any of the following (extent of occurrence; area of occupancy; area, extent, and/or quality of habitat; number of locations or subpopulations; number of mature individuals), and **extreme fluctuations** in any of the following (extent of occurrence; area of occupancy; number of locations or subpopulations; number of mature individuals). Due to its dependence on isolated wetlands in a landscape that has already been fragmented, it is apparent that the flatwoods salamander's distribution range-wide is highly discontinuous, and could be defined as "severely fragmented." Even with the protection of known populations and the discovery of additional ones, it seems likely that the flatwoods salamander's distribution will continue to be "severely fragmented." Until more comprehensive, long-term data on population numbers are available, determining the population trends of the flatwoods salamander range-wide will rely heavily on indirect measures such as presence or absence of larvae and availability of appropriate quality habitat. Documented increases in the amount of such habitat, locating additional populations while maintaining known populations, documented year-to-year persistence of larvae at given breeding sites, and documentation of increased numbers of adults would be important evidence suggesting the decline is no longer continuing. It is to be expected

that amphibian population numbers fluctuate dramatically from year to year due to differences in amount and duration of precipitation. In addition, natural succession throughout the landscape would be expected to result in the periodic creation and loss of the isolated wetlands upon which flatwoods salamanders depend for reproduction. Against this background of natural fluctuations, it may be possible to "hedge our bets" and prevent the extirpation of populations. For example, the 22 populations on public lands in Florida utilize at least 69 identified breeding sites (LaClaire pers. commun., Appendix 7), for an average of 3.14 known breeding sites per population. As an arbitrary signpost indicating a reduced likelihood that extreme fluctuations will cause local extinction, one could define a "robust" population as one known to be using 3 or more breeding sites, and a conservation objective could be to attain this level for all populations.

2a. **An extent of occurrence of greater than 7,700 square miles range-wide** (i.e., including other states as well as Florida). This area would equal a square about 88 miles on the side, or about 13% of Florida's total area of 58,560 square miles. According to the map in Conant and Collins (1991), the flatwoods salamander's extent of occurrence covers well over this amount of area. The Florida range maps given in Ashton (1992) and in Petranka (1998) show a suspected gap in distribution between Panhandle and Northeast Florida populations, but the implied total geographic range on each of those maps would still exceed 7,700 square miles. Therefore, it appears that this numerical criterion is already met.

2b. **An area of occupancy exceeding 770 square miles range-wide** (i.e., including other states as well as Florida). This area would equal a square about 28 miles on the side, or about 1.3% of Florida's total area. The amount of habitat actually used by a flatwoods salamander population includes the breeding pond or ponds and the associated surrounding flatwoods. Data on terrestrial habitat use are mostly lacking; Ashton (1992) reported on individuals that traveled up to 1 mile from their breeding pond, although other biologists dispute the meaning of such relatively long-distance movements (see Appendix 11). Assuming that such movements commonly and naturally occur in most flatwoods salamander populations, a population's minimum habitat requirements could be defined as that area around the pond extending 1 mile from the wetland edge. Therefore, a population using only 1 breeding pond would need a minimum of 3.14 square miles (the area of a circle $A = \eth r^2$ with radius r = 1 mile), if the pond area is represented by a point. As pond area increases, the idealized occupied habitat (based on pond radius added to the distance moved from the pond edge) would increase correspondingly. One could postulate that a population using 2 ponds would need less than double the amount needed for 1 pond, say 5 square miles; 3 ponds - 7 square miles; 10 ponds - 12 square miles; 21 ponds - 15 square miles. Using these conventions (Moler pers. commun.), the total area of occupancy for the 53 known populations range-wide is 231 square miles. At an average of 4.36 square miles per population (231 divided by 53), the minimum target area of occupancy of 770 square miles would contain 177 populations.

(It is worth noting that Species of Special Concern area of occupancy is defined as less than 770 square miles but greater than 200 square miles range-wide. The postulated range-wide area of occupancy of 231 square miles [see above] is very close to the minimum value for this category. Based on the postulated area occupied by an average population [see above], the loss of only 7 of the known extant populations [occupying an estimated 31 square miles], whether in Florida or in another state in the species' range, would be sufficient for the flatwoods salamander to fall below the minimum value for Species of Special Concern and meet the criteria of Threatened.)

It should be emphasized that this discussion is based on several successive assumptions, the most fundamental being the distance moved by individual flatwoods salamanders from their breeding site pond and the corresponding area of habitat required to support the average population using a given pond or set of ponds. As more data are acquired on these topics, biologists will be better able to quantify the relationship between salamander habitat use and area of occupancy.

Until such data are available, however, and as long as the assumptions are recognized, one can continue the above line of reasoning with respect to an area of occupancy conservation objective. Therefore, using the postulated average area occupied by a population as a "unit" of area of occupancy, and the number of populations as a coarse and indirect measure of the total area occupied, in order to exceed the criterion for Species of Special Concern, a minimum of 124 additional populations (covering 539 square miles) need to be found or restored range-wide. Florida has about 73% of the known populations (38; Appendix 7). If it is reasonable to assume that other *A. cingulatum* states (Georgia, South Carolina, Alabama) will implement comparable survey and management efforts, then to achieve its share of the target area of occupancy, Florida should have a total of 129 populations (0.73 x 177), and thus needs to find or restore 91 more populations. Based on the previous discussion, these 91 additional populations would occupy about 397 square miles, and complete Florida's area of occupancy objective of 562 square miles.

3. **Population Size and Trend.** Like the previous criterion, this criterion has a numerical component (discussed in 3a below) and a trend component. The trend criterion requires either an estimated continuing decline of at least 10% within 10 years or a continuing decline in numbers such that either no population contains more than 1,000 mature individuals or all individuals are in a single population. The latter 2 population criteria are apparently already exceeded (see below), but the Final Biological Status Report suggests that the flatwoods salamander may be expected to undergo at least a 10% decline based on current information. As discussed previously, documenting the reversal of such a continuing decline would require the collection of long-term data from populations across the species' range.

3a. **More than 10,000 mature individuals range-wide.** It is not known how many mature flatwoods salamanders would constitute a viable (stable, self-sustaining) population, and it is difficult to census them. The Final Biological Status Report suggested that the sum of all populations range-wide is less than 10,000 (but more than 2,500) mature individuals, but that the 3 largest populations known (all in Florida: 1 using 21 ponds on Eglin Air Force Base [AFB], 2 using 10 ponds each on Apalachicola National Forest [NF]) probably contain at least 1,000 mature individuals each, although supporting data are lacking at present. Means et al. (1996) captured as many as 36 mature individuals in 1 hour migrating across a 4.3-km stretch of highway in the early 1970s, and estimated that nightly migrations then involved 200-300 adults per night (compared to less than 1 per night in the early 1990s). Palis (1997a) used a drift fence encircling a 0.8 ha wetland in Eglin AFB to intercept immigrating and emigrating salamanders; he caught 67 non-yearlings one year and 53 the next. Similarly, Palis and Aresco (2000) captured 21 adults migrating to and from a 0.2 ha isolated wetland in Apalachicola NF (where, apparently due to water level fluctuations, they did not successfully reproduce that year; the low number of migrants probably reflect the poor conditions and the adult population is likely much larger than indicated). If the target threshold of 10,000 individuals were distributed evenly among the 177 populations postulated above, the average population would contain 56 mature salamanders. Although it is unknown whether this number could constitute a viable population, in order to exceed a range-wide population estimate of 10,000 adult flatwoods salamanders, a conservation objective could be to count a minimum of 56 adults per population. This would be a highly impractical objective, however; the long-term investment of equipment and personnel would make this prohibitively expensive to pursue at more than a handful of populations.

4. **Population Very Small or Restricted.** Current information on flatwoods salamander population estimates and distribution suggest that this criterion is already exceeded.

5. **Quantitative Analysis.** As indicated in the Final Biological Status Report, available data are not sufficient to permit estimation or modeling of the probability of extinction of flatwoods salamanders in the wild.

APPENDIX 10. Flatwoods Salamander Proposed Conservation Zones

Designate 5 conservation zones for Florida flatwoods salamanders:

1. Populations in 5 western Panhandle counties (Escambia, Santa Rosa, Okaloosa, Walton, Holmes), including Eglin Air Force Base
2. Populations in 5 central Panhandle counties (Washington, Bay, Jackson, Calhoun, Gulf) west of Apalachicola River
3. Populations in 6 eastern Panhandle counties (Gadsden, Liberty, Franklin, Leon, Wakulla, Jefferson), including Apalachicola National Forest and St. Marks National Wildlife Refuge
4. Populations in 10 "gap" counties in central North Florida where salamanders have not yet been recorded (Madison, Taylor, Hamilton, Suwannee, Lafayette, Dixie, Columbia, Gilchrist, Levy, Citrus)
5. Populations in 12 northeast Florida counties, some of which have historic or extant populations, including Osceola National Forest (Baker, Union, Bradford, Alachua, Marion, Nassau, Duval, Clay, Putnam, St. Johns, Flagler, Volusia)

Zone 1: Complete surveys of Eglin; implement conservation actions to ensure long-term health of Eglin populations; monitor populations on annual basis; cooperative agreements with private landowners for long-term management of populations on their land; resurvey Escambia and other counties, especially Blackwater River State Forest, for additional populations

Zone 2: Complete surveys of Pine Log State Forest and Point Washington State Forest; implement conservation actions to ensure long-term health of those populations; monitor population(s) on annual basis; cooperative agreements with private landowners for long-term management of populations on their land; resurvey Bay, Gulf, and other counties for additional populations

Zone 3: Complete surveys of Apalachicola National Forest (including searching Franklin, Wakulla, and Leon portions for additional populations), St. Marks National Wildlife Refuge, and Tate's Hell State Forest; implement conservation actions to ensure long-term health of those populations; monitor populations on annual basis; resurvey Franklin, Wakulla, and other counties for additional populations

Zone 4: Implement surveys of all potential habitat in "gap" counties; ascertain likelihood of past and present occupancy by flatwoods salamanders

Zone 5: Complete surveys of Osceola National Forest; implement conservation actions to ensure long-term health of Osceola populations; monitor populations on annual basis; cooperative agreements with private landowners for long-term management of populations on their land; resurvey all counties in region for additional populations

APPENDIX 11. Flatwoods Salamander Movement and Home Range Information

- Two of 4 radioactively tagged adult salamanders moved over 1,700 m, and a third moved over 1,560 m, from the breeding pond and into surrounding pine flatwoods at edge of planted slash pine (Ashton 1992, pers. commun.); Ashton's (1992) suggestion of large home range size needs more data to substantiate (Ashton pers. commun.).

- A group of salamander biologists (Jensen 1998) "felt that Ashton's distance represented only an extreme incident and a buffer with radius 1.7 km is far too much to ask and probably unnecessary to protect a population." Instead they (Jensen 1998) recommended adopting a buffer based on Semlitsch (1998), wherein 164.3 m from the wetland edge was the average movement for several *Ambystoma* spp. (but not including *A. cingulatum*). Semlitsch (1998) admitted that his value may be an underestimate for *A. cingulatum*, but he suggests (Semlitsch pers. commun.) that the long-distance movements reported by Ashton (1992) represent movements important for connectivity between populations, but not for local population persistence.

- Migrating individuals move up to 500 m or more from breeding ponds (Means et al. 1996).

- although yearling males may be physiologically mature, evidence suggests that yearlings are not normally members of the breeding population (Palis et al. 1995, Palis 1997a)

- Most migrating salamanders entered ponds from open-canopy, mesic longleaf pine-wiregrass and longleaf/slash pine-wiregrass flatwoods, rather than xeric (longleaf/slash pine scrubby) flatwoods (Palis et al. 1995, Palis 1997a).

- Flatwoods salamanders display emigration orientation in direction of immigration to breeding pond, suggesting ability to home to and from a particular terrestrial retreat (Palis et al. 1995, Palis 1997a).

- Adults emigrating from breeding pond apparently moved nocturnally, and were not observed to leave the cover of pine duff. They were last encountered using 18- to 22-mm smooth-sided burrows under the leaf litter, where they remained at an apparent depth of more than 0.5 m below the surface. When excavated, these burrows were found to be connected with a series of burrows of unknown origin and at different levels in the soil, and neither the salamanders nor their radioactive tags could be successfully relocated (Ashton pers. commun.).

- Metamorphs may stay in pond basin if a dry year, and not emigrate until fall (Palis 1997a, Palis and Means in press).

APPENDIX 12. Reviewers of Flatwoods Salamander Draft Management Plan

Listing Process Stakeholders

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